

CHAPTER 16

Intermediate Silvicultural Treatments

(Chapter Background Photo WDNR, Joe Kovach)

CHAPTER 16
INTERMEDIATE SILVICULTURAL TREATMENTS

Integrated Resource Management Considerations 16-2

PLANNING 16-3

OPERATIONAL CONSIDERATIONS 16-4

 Release 16-4

 Thinning 16-6

 Thinning Clumps of Trees 16-11

 Improvement Cutting 16-12

 Salvage and Sanitation Cutting 16-12

 Pruning 16-13

POST-OPERATIONAL ACTIVITIES..... 16-14

BMPs: Invasive Species 16-14

RESOURCES FOR ADDITIONAL INFORMATION 16-15

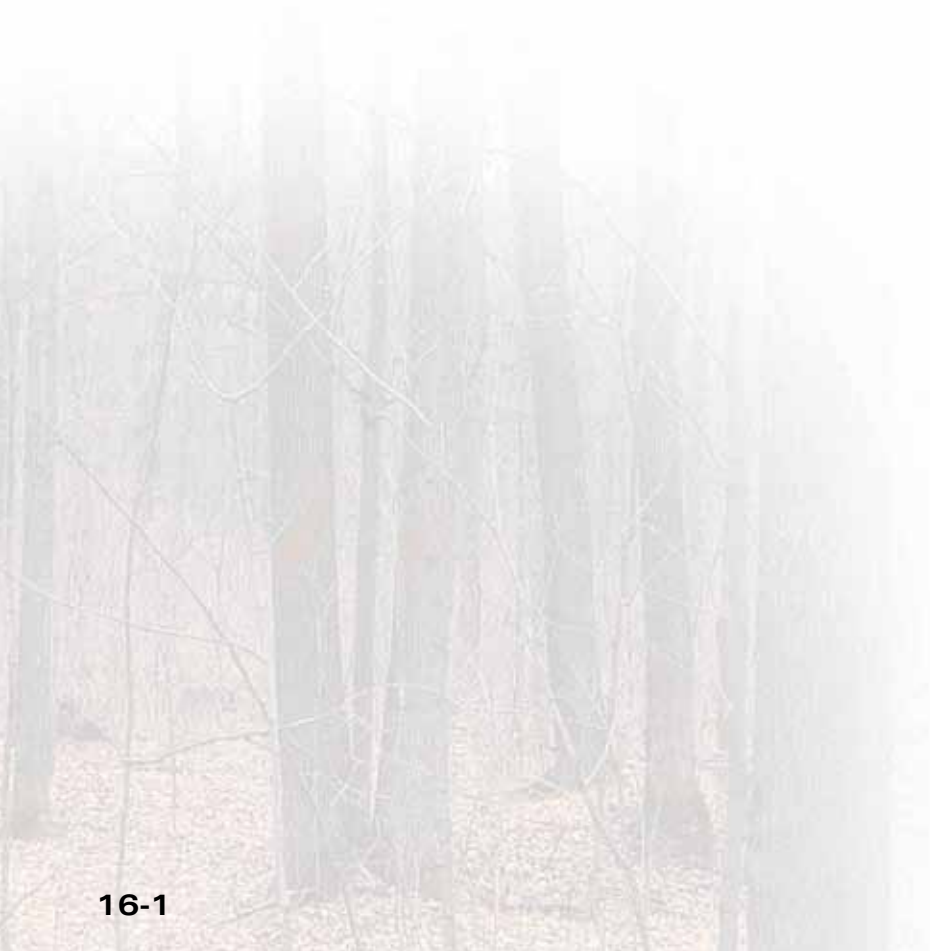




Figure 16-1 and 16-2: The importance of tending an even-aged stand is illustrated by comparing these two plots in the famous Star Lake thinning experiment started by Fred Wilson with red pine planted in 1913. Figure 16-1 (left) shows the poor growth and mortality in the plot that was never thinned. The adjoining plot, Figure 16-2 (right), shows the impact that periodic thinnings (every five to 10 years starting in 1943) can have on red pine growth and quality.

Intermediate treatments begin after regeneration is established and are carried out as prescribed throughout the life of a forest stand. These treatments make up the “tending” portion of an overall silvicultural system. **Primary goals include improvement of stand composition, structure, growth, quality, health, and the production of specific benefits desired by the landowner.** Some intermediate treatments, often called **timber stand improvement (TSI)**, are non-commercial, requiring outright investment by the landowner. Other intermediate treatments can yield income.

Integrated Resource Management Considerations

- Intermediate treatments can affect timber productivity, stand structure, wildlife habitat, species and habitat diversity, aesthetics, water quality, and soil condition. Careful consideration must be given to all the ramifications of a planned treatment.
- Intermediate treatments generally improve tree vigor and health, but high intensity treatments in stands lacking vigor and strength can cause stress and short-term predisposition to health problems. Logging damage can cause wounds that predispose trees to future health problems.
- Invasive plants can be encouraged or discouraged by intermediate treatments and operations. They can preclude the success of treatments. Invasive plants should be controlled and/or eliminated during intermediate treatments to the greatest extent possible (see 4.2 through 4.6).
- Intermediate treatments can increase visual penetration and access. Season or hours of operations may need to be restricted to mitigate visual impacts.
- Heavy equipment can damage cultural resources.

PLANNING



Figure 16-3: Having a trained forester collect inventory data for each stand on the property is necessary before prescriptions can be developed to achieve the management objectives.

- Conduct on-site meetings with the landowner, forest resource manager, and logger prior to implementing operations. Clarify objectives, specifications, regulations, and site limitations.
- Identify crop tree management objectives, characteristics, number per acre and spacing.
- Consider the retention of wildlife trees, snags, and coarse woody debris.
- In some cases, logging residues (slash) and stumps can facilitate infestations, and may require treatment. Timing of cutting (and other operations) should consider disease and insect cycles.
- Evaluate soil conditions and control heavy equipment operations to limit compaction, rutting, and erosion.
- If necessary, evaluate the need for additional slash control measures, or seasonal operating restrictions to mitigate visual impacts.
- Identify any cultural resources that may occupy the site and develop measures to protect them.
- Identify occurrences of invasive species, and, if necessary, treat infestations prior to conducting stand improvement activities to help prevent spread (see [3.2](#) and [4.2](#)).



Figure 16-4: Frequent communication between the forester, landowner and other resource professionals helps insure that management objectives are fully achieved.

OPERATIONAL CONSIDERATIONS

Intermediate treatments can be grouped into release, thinning/improvement, salvage/sanitation, and pruning operations.

Consider invasive species when conducting intermediate treatments (see 4.3 through 4.6).

Release

Release is a treatment designed to free young trees (saplings and seedlings) from undesirable, usually overtopping, competing vegetation. **The purpose is to regulate species composition and to improve growth and quality.** Release treatments are designed to provide potential crop trees with sufficient light and growing space, by freeing their crowns and controlling competition.

The need for release treatments are based on a number of considerations.

- An assessment of the relative growth rates (height growth in particular) of the competing and desired species.
- The degree of impact the competing species has on the health and vigor of the desired species.
- The relative cost/effectiveness of a partial versus complete release versus no action.

Complete release involves the release of an entire layer of vegetation. Examples would be the control of aspen suckers and brush in a new pine plantation, or the control of competing red maple stump sprouts after the establishment of red oak seedlings following a shelterwood harvest. In these situations, essentially all of a particular species in the stand are considered crop trees. The objective is not necessarily to kill the competing species, but to set back and/or retard their growth so as to allow the desired species to gain dominance. A complete release normally occurs soon after a new stand is established, when competing vegetation begins to interfere with the free growth of the desired species and/or individuals.

Partial release involves the release of only selected crop trees. A partial release is usually done before

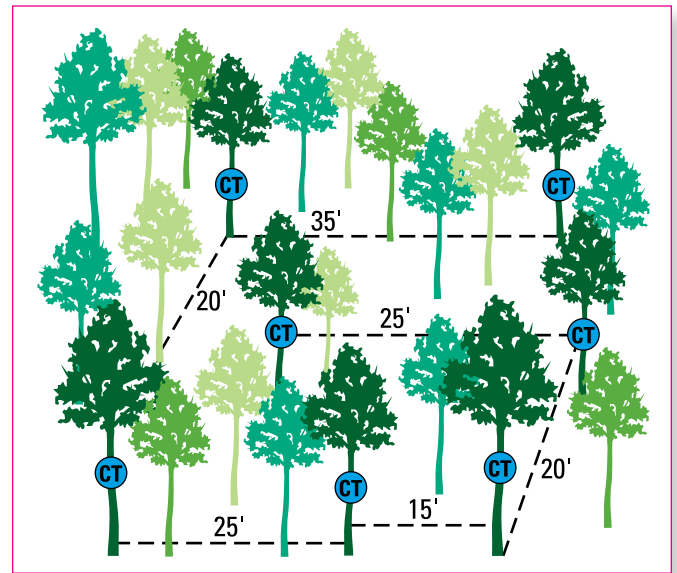


Figure 16-5: Spacing is an important consideration when selecting crop trees (CT). If you space crop trees 25' apart, you will end up with about 70 crop trees per acre. Some crop trees can be spaced 15' apart, while others can be spaced 35' apart.

the main stand is 15 years of age, and involves the following criteria:

- Crop trees are selected based on landowner objectives, species, tree vigor, and tree quality. The maximum number of well-spaced crop trees per acre generally ranges from 50 to 200, depending on landowner objectives and stand condition (see the crop tree selection guidelines in Appendix A).
- Only the direct competitors are cut. Any plant that is not going to suppress, endanger, or hamper the growth of desired individuals is left to grow. All trees with crowns that touch or interfere with each crop tree are removed.
- When sprout clumps are involved, all but the best one or two stems are cut. Healthy, low sprouts originating from the root collar, with a U-shaped stem attachment, of a relatively large size, well-shaped and with a well-developed crown, are selected for retention.

There are three types of release treatments: weeding, cleaning, and liberation. They are differentiated based on the type, age, and size of vegetation eliminated. Within a stand, they can be applied individually or in concert, once or multiple times.

WAYS TO CONTROL COMPETING SPECIES

Physically Tear the Plant Out of the Soil

- A very effective but expensive method.

Cutting

- Most effective against species that do not sprout, e.g., most conifers.
- Species that sprout may require repeated treatments to effectively control. Cutting in late spring and summer is most effective.
- Relatively expensive, unless a product can be harvested.

Girdling (see Figure 16-6)

- Most effective against species that do not sprout.
- Most effective when done in late-spring and summer.
- Generally applied only to trees greater than 4" DBH.

Fire

- Usually kills trees by girdling.
- Generally not used to release young trees.

Herbicides

- Very effective and often the most cost-effective.
- Methods of application include: aerial spraying, ground-level foliar spraying, basal spraying, stump spraying, and bark incisions.
- Herbicides are toxic chemicals, see Chapter 14: Pesticide Use.

Some general operational considerations relative to release treatments that remove large, overtopping trees are:

- Cutting may allow the realization of income, but protection of the young stand from felling and harvesting operations is critical.
- Care should be taken that following the elimination of high shade, intense crown competition from sprouts or the release of fast growing weed species does not develop.
- Reserve trees retained from the previous stand can provide benefits related to wildlife, aesthetics, water and soil quality, protection of special or sensitive sites, landmarks, and, in certain cases, timber production. Where objectives include the retention of reserve trees, residual crown closures of less than 15 to 20 percent generally will not significantly impair the development of the young stand (see Appendix A).
- In most cases, nearly full sunlight is preferred to promote optimum growth of young, established stands.



(WDNR, Jeff Martin)

Figure 16-6: Girdling can be an effective way to remove selected larger trees from a stand with minimal damage to surrounding reproduction.

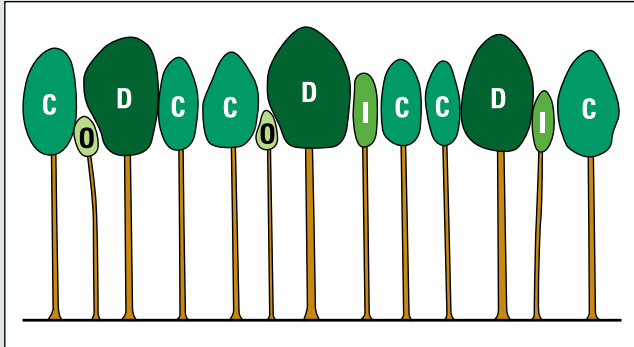


Figure 16-7: This illustration shows the relative positions of trees in the different crown classes in an even-aged stand that has not been thinned. (Adapted from © David M. Smith, 1962, *The Practice of Silviculture* (7th Edition), John Wiley & Sons, Inc.)

DOMINANT (D)

Dominant trees have crowns extending above the general level of the crown cover, and receive full light from above and partly from the side. Dominant trees are larger than the average trees in the stand, and have well-developed crowns that may be somewhat crowded from the sides.

CODOMINANT (C)

Codominant trees have crowns forming the general level of the crown cover, and receive full light from above but comparatively little from the sides. These trees usually have medium-sized crowns that are often crowded on the sides.

INTERMEDIATE (I)

Intermediate trees are shorter than dominant and codominant, but have crowns extending into the crown cover formed by codominant and dominant trees. Intermediate trees receive a little direct light from above, but none from the sides. They usually have small crowns that are considerably crowded on the sides.

OVERTOPPED (O)

Overtopped, also called suppressed, are trees with crowns entirely below the general level of the crown cover. Overtopped trees receive no direct light either from above or from the sides.

Thinning

Thinning is a cultural treatment, conducted in stands past the sapling stage, made to reduce the stand density of trees primarily to improve growth, enhance forest health, or recover potential mortality. Typically, **it entails the removal of trees to temporarily reduce stocking to concentrate growth on the more desirable trees.** Normal thinning does not significantly alter the gross production of wood volume. Thinning impacts stand growth, structure and development, and increases economic yields. Individual thinnings can be commercial or non-commercial (TSI), depending on landowner objectives and local markets for materials cut in the thinning operation.

How and when thinnings are applied depends on landowner objectives and the desired benefits.

A schedule of thinning for a stand should identify the thinning methods to be used, the intensity of application, and when thinnings will occur. Ideally, a thinning schedule should be systematic, flexible, and consistently followed throughout the rotation. In selecting trees for thinning, primary focus should be on the trees that will remain (the principle crop), as opposed to those to be cut.

There are four basic methods of thinning. Stand conditions and thinning needs vary over time, often resulting in the application of more than one method over a stand's rotation. The four methods of thinning are: mechanical thinning, low thinning, crown thinning, and free thinning.

MECHANICAL THINNING

Mechanical thinning is the removal of trees in rows, strips, or by using fixed spacing intervals.

- Frequently, these are the first thinnings in young stands that are densely crowded and/or relatively uniform with little differentiation into crown classes. This method becomes less suitable as variation in the size and quality of the trees increases.
- **Row thinnings** (see Figure 16-8) cut all trees in rows or strips at fixed intervals throughout the stand. They are often utilized for the first thinning(s) in plantations where the rows are readily apparent. The removal of every third row is the most common practice. They are also used to provide access for harvesting equipment in dense, unthinned stands.
- **Spacing thinnings** involve selection of trees at fixed intervals for retention and cutting the rest. This strategy is most applicable as the first thinning in very overcrowded young stands developed from dense natural reproduction.

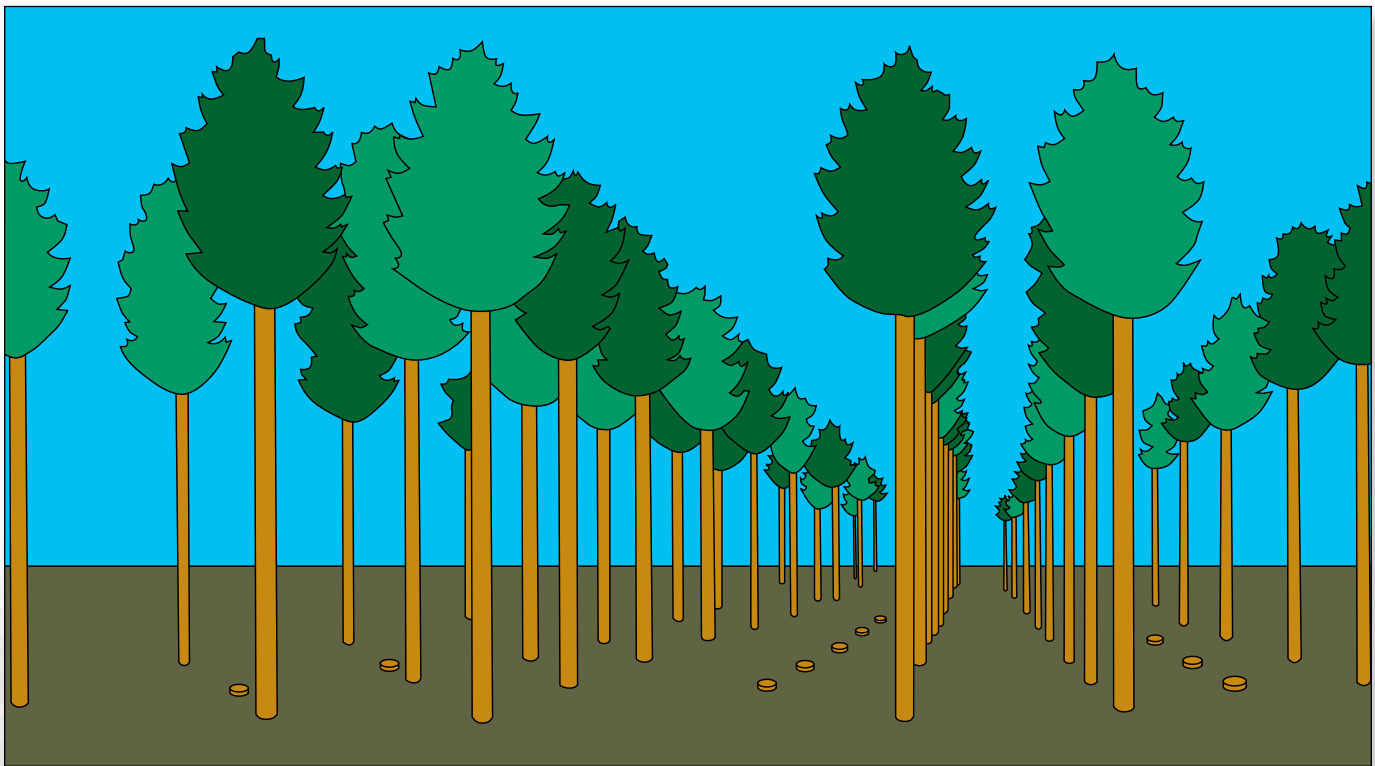


Figure 16-8: A mechanical row thinning in a pine plantation in which every third row of trees has been removed. The opening in the canopy should close in a few years. (Adapted from Fact Sheet G3398, Wisconsin Woodlands: Intermediate Cuttings in Forest Management, University of Wisconsin-Extension)

LOW THINNING

Low thinning, or thinning from below, (see Figure 16-9) involves removal of trees from the lower crown classes to favor those in the upper crown classes. This strategy of removing the smallest trees and retaining the largest trees accelerates and simulates somewhat the natural elimination of the lower crown classes through competition.

- This type of thinning generally removes smaller diameter trees, and marketability can sometimes be difficult.
- Light- to medium-intensity low thinnings (removing suppressed and intermediate trees) are not recommended except in specific cases. They facilitate utilization of trees that would otherwise die due to suppression (competition), but the release of the remaining trees from competition is minimal.
- Heavy low thinnings are generally recommended. They involve the removal of some codominants in order to create canopy openings and release the crowns of crop trees to stimulate their growth. Stocking guides are used to help determine residual density levels.

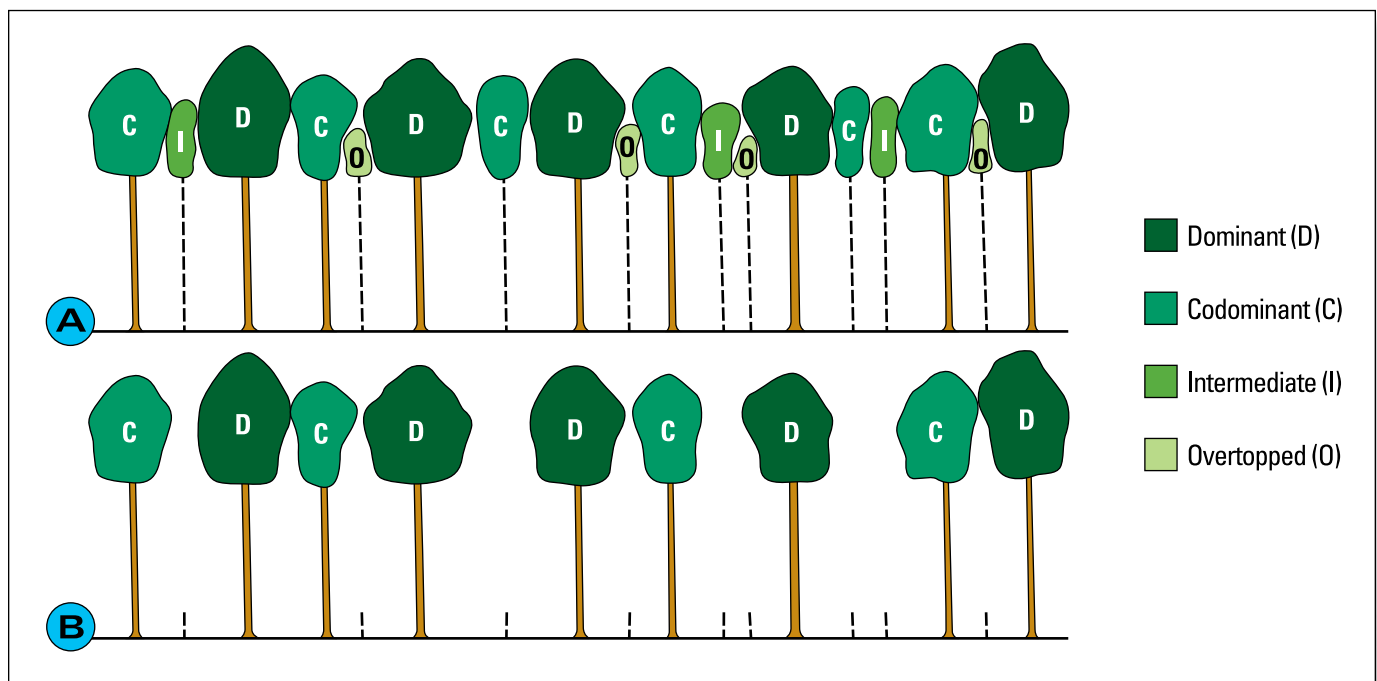


Figure 16-9: How a stand might look before (A), and after (B), a low thinning. The letters on the tree crowns denote crown classification. (Adapted from © David M. Smith, 1962, *The Practice of Silviculture* (7th Edition), John Wiley & Sons, Inc.)

CROWN THINNING

Crown thinning, or thinning from above, (see Figures 16-10 and 16-11) involves removal of trees from the dominant and codominant crown classes in order to favor the best trees of those same crown classes. Large intermediates that interfere with crop trees also can be removed. The method stimulates the growth of selected, preferred trees (quality) without sacrificing the production of quantity.

- Crown thinnings are normally used to develop quality sawtimber. They are usually commercial operations and the trees removed are relatively large.
- Crop trees are selected based on landowner objectives, species, vigor, quality, strength, and health (see Appendix A: Crop Tree Selection).
- Crown thinnings are a recommended method to develop and manage quality hardwood stands for the production of high value sawtimber and veneer logs.
- 40 to 150 well-spaced dominant and codominant crop trees per acre are released. In fast growing young stands with small crowned competitors, crop trees are released on four sides. In slower growing older stands with larger crowned competitors, crop trees are released on one to three sides.
- To optimize growth, the remaining stand should also be thinned. Release the best dominant and codominant trees by removing high risk, lower vigor, poorer quality competitors. Stocking guides are used to determine residual stand density.
- To be most effective, crown thinning requires considerable skill in tree selection and density management. The timing and intensity of a particular thinning is important in managing stem form and natural pruning.

FREE THINNING

Free thinning is the removal of trees to control stand spacing (density) and favor desired crop trees using a combination of thinning criteria without strict regard to crown position. In application, this method is a free combination of selected concepts and techniques garnered from both low and crown thinning methods.

Follow crop tree selection and order of removal guidelines (Appendix A).

Utilize stocking guides to help determine target residual density. Free thinning is recommended to develop and manage quality hardwood stands for the production of high value sawtimber and veneer logs. Free thinning requires considerable skill in tree selection and density management to be effective.



Figure 16-10: This crop tree, released on two to three sides by cutting competing trees, is now free to grow.

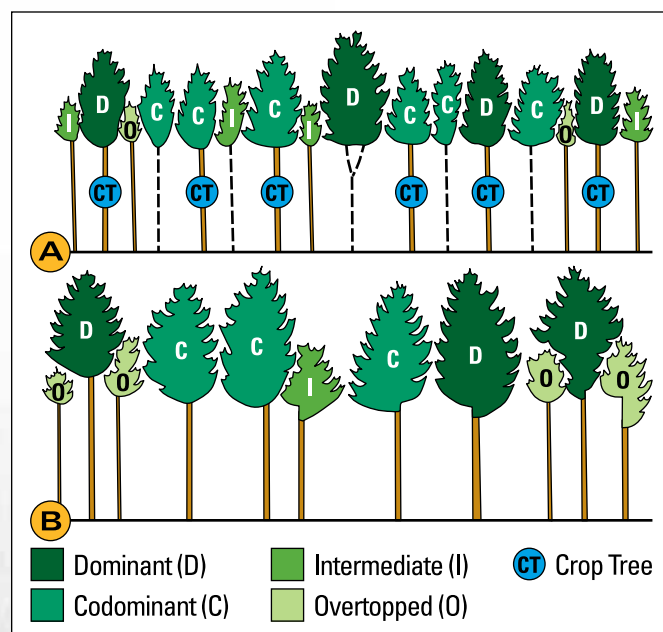


Figure 16-11: The upper sketch (A) shows a coniferous stand immediately before a crown thinning. The crop trees are indicated by the blue circles marked "CT." The lower sketch (B) shows the same stand about 20 years after the crown thinning, which has reclosed to the point where a low thinning would be desirable. (Adapted from © David M. Smith, 1962, *The Practice of Silviculture* (7th Edition), John Wiley & Sons, Inc.)

SOME OPERATIONAL CONSIDERATIONS RELATIVE TO THE TIMING AND INTENSITY OF THINNING OPERATIONS

- The timing and intensity of each thinning depends on landowner objectives, stand composition and structure, stand condition and health, and other past and planned management activities. A tentative schedule should be developed, indicating the projected timing and intensity of each thinning. Time oak harvests to minimize the risk of introducing the fungus that causes oak wilt. For more information, visit <http://dnr.wi.gov/forestry/fh/oakWilt/guidelines.asp>.
- The intensity of thinning refers to the proportion of the stand removed in a particular thinning.
- As intensity increases, frequency usually decreases.
- Target stocking levels are determined based on optimizing stand growth and yield for a specific forest cover type. Stocking guides (see Figure 16-12) define the lower and upper limits of stand density on a given site. The lower limit (see Figure 16-12, B-line) is normally used to guide thinning applications. Regular reduction of stand density to the lowest level at which full occupancy is maintained should result in the most rapid diameter growth that can be maintained without reduction in total volume yields.
- Initial thinnings normally begin when crowns begin to touch each other. Precommercial thinning (TSI) requires an investment, but can increase net returns over the rotation. It is typical, however, to postpone the initial thinning until an immediate profit can be produced.
- Normally, a thinning is indicated when 1) the live crown ratios of crop trees begin to decline, 2) the diameter growth of crop trees begins to decline, 3) stand density increases to near or above specified upper limits delineated in stocking charts, and/or 4) sufficient timber volume accumulates to support a harvest.
- The effects of thinning are temporary. After each thinning, the remaining trees grow taller, diameters increase, crowns expand, and canopy gaps close.

- Thinning every eight to 15 years is a recommended general guideline for commercial thinnings.

It is important to control logging damage when thinning. Logging wounds can predispose the remaining trees to disease and decay. Thinnings are meant to increase resistance to damage (insects, disease, wind, etc.), however, they can also temporarily predispose stands to damage, especially where trees are not particularly vigorous or strong.

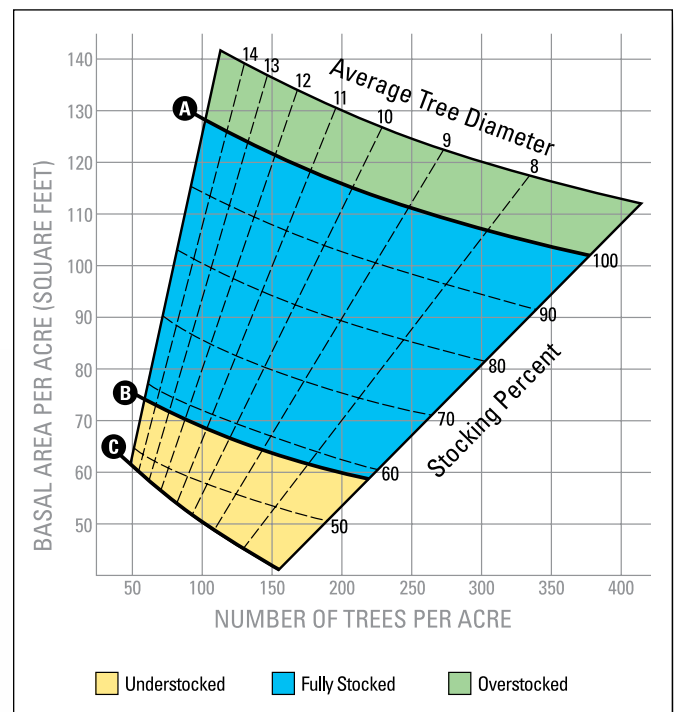


Figure 16-12: Stocking guide/chart for upland central hardwoods displaying the relation of basal area, number of trees, and average tree diameter (the tree of average basal area) to stocking percent. The area between A-line and B-line indicates the range of stocking where trees can fully utilize the site. C-line shows the limit of stocking necessary to reach the B-line level in 10 years on average sites. Similar guides are available for each species. (Adapted from I. L. Sanders, 1977, *Manager's Handbook for Oaks in the North Central States*, USDA Forest Service General Technical Report, NC-37, North Central Forest Experiment Station, St. Paul, MN)

Thinning Clumps of Trees

Clumps refer to root, root collar, or stem sprouts, as well as trees of seed origin growing in close proximity to one another so their lower boles contact each other or have the potential to contact each other. They commonly occur in hardwoods. **Clump thinning** is the removal of some, but not all, tree members of a clump. This practice can predispose residual trees to butt rot, stain, or wilt disease, which enter directly from adjoining cut sprouts or wounds made while clump thinning. To minimize decay in the lower bole and to avoid some wilt diseases, it is generally recommended to avoid clump thinning pole-sized or larger clumps by either leaving or removing all stems in a clump.

Though it is best to thin clumps before trees reach pole-size or larger, some stands will have an overabundance of clumps in larger diameter classes. If the stand has the potential to produce quality hardwood logs, consider the complete removal or full retention (versus thinning) of clumps. If choosing to thin clumps, cut only those stems that originate at the root collar or below, connect in a U-shape union, and which allow for cutting without wounding residuals. Also, consider species specific susceptibility to decay and the potential for disease introductions (e.g., oak wilt and sapstreak) (see Figures 16-13 through 16-16).



Figure 16-14: Avoid thinning sprouts that are attached above the root collar like the cut sprouts shown here (white arrows). The residual basswoods will develop butt-decay because of this practice.



Figure 16-13: A residual tree with butt-rot due to clump thinning. The cut stem was connected to the residual stem in a V-shape. The residual stem was wounded when the other stem was cut (white arrow points to chain saw wound). This facilitated the decay. Decay may have also transferred directly from the cut stem into the residual stem.



Figure 16-15: A sugar maple clump with stems originating at the root collar and meeting in a narrow-angled V-shape. Thinning is not recommended because the chances of wounding the residual in this clump is high. It is recommended to take or leave both stems.



Figure 16-16: One of these stems could be thinned without great risk for decay in the residual because they have a U-shaped connection at the root collars. Thinning clumps with U-shaped unions has been shown to result in less decay than thinning clumps with V-shaped unions.

Improvement Cutting

Improvement cutting is the removal of less desirable trees of any species in a stand of poles or larger trees, primarily to improve composition and quality. Trees are removed to encourage the growth of more desirable trees within or below the main canopy. Trees considered for removal include undesirable species, trees of poor vigor, trees of poor quality, and injured or unhealthy trees. Potential crop trees should be a preferred species and relatively well-formed, vigorous, and healthy.

Improvement cuttings are applied to stands that have been unmanaged, neglected, or poorly managed. The intent is to remove undesirable material, and set the stage for productive management to accomplish landowner objectives. In most cases, stand improvement can be completed in one to three operations. In cases where the current stand is of such poor quality that rehabilitation is untenable, the preferred choice is to initiate regeneration to develop a vigorous, new stand.

Salvage and Sanitation Cutting

Salvage cutting is done to remove dead, damaged, or dying trees resulting from injurious agents other than competition. The goal is to recover economic value that would otherwise be lost. Salvage operations are done for profit, with the intent of utilizing damaged trees and minimizing financial losses. Salvage should be conducted

as soon as possible following a damaging event. Dead trees deteriorate rapidly during the first growing season after death yet not all species degrade at the same rate and not all injuries have the same impact. Severe stand damage will require the implementation of regeneration methods. Before implementing salvage operations, consider potential impacts on other resource benefits (e.g., water quality, wildlife, and biodiversity) and possible mitigation measures.

Presalvage cutting involves removal of valuable trees at high risk of injury or mortality from damaging agents. The method attempts to anticipate damage by removing vulnerable trees that are in imminent danger of being damaged or killed.

Sanitation cutting removes trees that are a threat to stand health by stopping or reducing the actual or anticipated spread of insects such as pine bark beetles or diseases such as oak wilt. It is precautionary protection implemented to reduce the spread of damaging organisms, or in anticipation of attacks to prevent or delay the establishment of damaging organisms. Sanitation cuttings eliminate trees that are present or prospective sources of infection for insects or fungi that might attack other trees. The removal of trees must actually interrupt the life cycle of the organisms sufficiently to reduce their spread to other trees. In some cases, simply removing infested or infected material is one part of several steps needed to mitigate an insect or disease issue. Consult information related to specific pest in order to understand all of your options.



Figure 16-17: An improvement cut in this upland hardwood stand removed overtopping, undesirable trees, thus “releasing” small poletimber from competition that reduces growth rate.

Pruning

Pruning is a silvicultural technique, typically applied to improve timber quality and value. It is the removal, close to the branch collar or flush with the stem, of side branches and multiple leaders from a standing tree. Branches are removed because they form knots, which are a common defect of lumber, and reduce timber value. The retention of large, dead branches low on the trunk is particularly counterproductive. Multiple leaders are removed to improve stem form. Sometimes, pruning is applied to control disease, or improve aesthetics or accessibility.

Pruning is expensive. Only the best quality crop trees on good sites should be selected for pruning. It is most commonly applied to conifer plantations of species which are poor natural pruners, but which can significantly increase value by producing clear lumber (e.g., white and red pines). Pruning can enable more aggressive thinning strategies, if the promotion of natural pruning is no longer a concern. Combining pruning and aggressive thinning can facilitate the production of increased value in a shorter period of time, by stimulating rapid healing of wounds and promoting the production of clear wood.

Some operational considerations relative to pruning are:

- Candidates for pruning should be the most vigorous, healthy, dominant (tallest), and largest diameter crop trees for the dominant age class – the very best individuals.
- Before implementing, identify the minimum tree specifications and the maximum number per acre. Typically 50 to 200 crop trees are pruned per acre, generally in two to three operations.
- A typical final objective as a result of pruning is a clear trunk to 17 feet; prune at least to nine feet. Each pruning is done to the topmost whorl of dead branches or into the lower portion of live crown. The ratio of live crown to tree height after pruning should exceed 50 percent.
- Cuts should be made just outside of the branch collar (swollen tissue when branch meets stem) and not flush with the stem. Do not tear or loosen bark in the branch collar area. Combining hand and pole saws provides an effective and economical choice. Other tools and machines are available, and may be preferable depending on species, limb characteristics, and pruning height.
- Careless, poorly implemented pruning can cause tree injury. Avoid excessive green pruning of live branches.
- The best time to remove a branch is just before death or within several years thereafter.
- Pruning should occur in young stands before the lower branches become relatively large. Removing large (greater than one to two inch diameter), live branches can damage quality.
- Pruning is best done in the dormant season – fall to late-winter is best. Time pruning of oak to minimize the risk of introducing the fungus that causes oak wilt. For more information, visit: <http://dnr.wi.gov/forestry/fh/oakWilt/guidelines.asp>.
- The first pruning should be in young, vigorous poletimber, following early initial thinning.

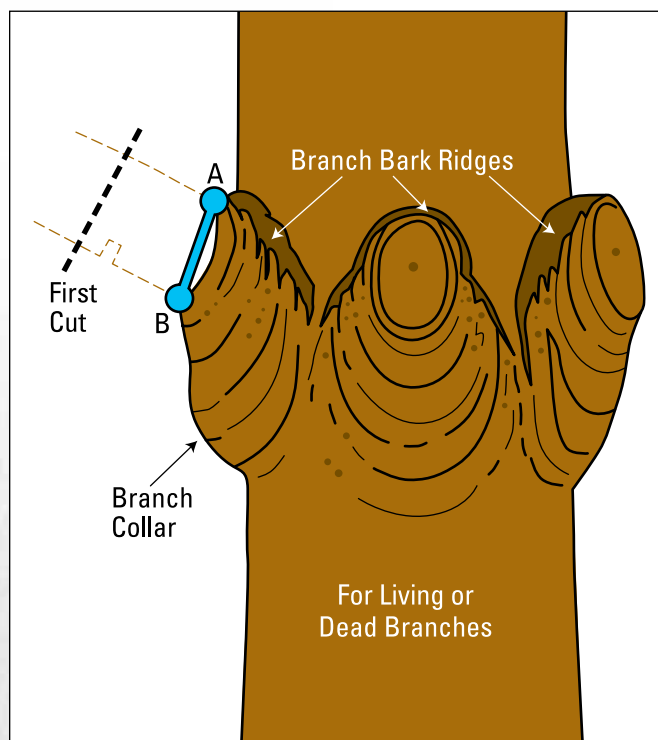


Figure 16-18: When pruning, leave the branch collar. Cut from point "A" to point "B."

POST-OPERATIONAL CONSIDERATIONS

- Rehabilitate landings, skid trails, and access roads to mitigate soil erosion, rutting, compaction, and the spread of invasive plants (see 🍃 6.2).
- Monitor and control any new infestations of non-native invasive plants. Clean equipment before moving from any infested site to an area that is free of invasive plants (see 🍃 4.2, 🍃 4.4 and 🍃 4.5).
- Careful records should be kept of intermediate treatments in order to assess the growth response, economic viability, and the need to refine future thinning schedules.

BMPs: Invasive Species

- 🍃 3.2 Prior to implementing management activities, scout for and locate invasive species infestations, consistent with the scale and intensity of operations.
- 🍃 4.2 If pre- or post-activity control treatments are planned, ensure that they are applied within the appropriate time window.
- 🍃 4.3 Consider the likely response of invasive species or target species when prescribing activities that result in soil disturbance or increased sunlight.
- 🍃 4.4 Prior to moving equipment onto and off of an activity area, scrape or brush soil and debris from exterior surfaces, to the extent practical, to minimize the risk of transporting propagules.
- 🍃 4.5 Take steps to minimize the movement of invasive plants, insects, and diseases to non-infested areas, during forest stewardship activities.
- 🍃 4.6 Take reasonable steps to avoid traveling through or working in small, isolated, populations of invasives during forest stewardship activities.
- 🍃 6.2 Revegetate or reforest as quickly as feasible after site disturbance.



Figure 16-19: A dense thicket of non-native invasive honeysuckle on one side of a property fence. Honeysuckle on the near side was cut, and the stumps were treated with herbicide.



Figure 16-20: Seeding can be as easy as spreading grass seed by hand as this landowner is doing on his freshly-graded woods road. Use non-invasive species and certified weed-free seed.



Figure 16-21: Retaining slash on skid trails is an effective way of reducing soil compaction and rutting from use of heavy logging machines.

Revised 2011

CROP TREE MANAGEMENT IN EASTERN HARDWOODS

THE DICTIONARY OF FORESTRY

INTERMEDIATE CUTTINGS IN FOREST MANAGEMENT

NATURAL DISTURBANCE AND STAND DEVELOPMENT PRINCIPLES FOR ECOLOGICAL FORESTRY

THE PRACTICE OF SILVICULTURE

SILVICULTURE: CONCEPTS AND APPLICATIONS

Silviculture: Concepts and Applications. Nyland, R. D., New York: McGraw-Hill, 1996.

SILVICULTURE HANDBOOK

Silviculture Handbook. Publication Number 2341.5,
Wisconsin DNR, Madison: Wisconsin DNR, 2010.

NOTES